City University of Hong Kong
Course Syllabus

offered by Department of Economics and Finance
with effect from Semester A 2024/25

Part I Course Overview

Course Title:	**Stochastic Calculus for Finance**
Course Code:	**EF5250**
Course Duration:	**1 semester**
Credit Units:	**3**
Level:	**P5**
Medium of Instruction:	**English**
Medium of Assessment:	**English**
Prerequisites: *(Course Code and Title)*	**Nil**
Precursors: *(Course Code and Title)*	**Nil**
Equivalent Courses: *(Course Code and Title)*	**Nil**
Exclusive Courses: *(Course Code and Title)*	**Nil**

Part II Course Details

1. Abstract

This course is designed to enhance students' mathematical ability, and equip them with the basic knowledge and skills of stochastic calculus for financial applications. Students will be introduced to stochastic processes, Brownian motion, and Ito calculus. Student will learn how to use quantitative analysis to derive the Black-Scholes formula for various types of options (European options, etc). At the end of this course, students will be able to price various types of options and construct hedging strategies.

The course also aims to develop students' creative and innovative abilities through various assessment tasks that involve the discovery and innovative process. Classes will encourage students to develop their discovery abilities through problem solving and class discussions. Stress will also be placed on common pricing and hedging problems in global financial markets to help students to discover the basic knowledge in the finance industry.

Assignments will require students to discover and innovate through the use of mathematical concepts. Students will get to know how to use these theories to come up with their own analyses on different financial products.

The final exam which covers topics discussed in the lectures and tutorials will reveal the students' accomplishments in discovery and innovation.

2. Course Intended Learning Outcomes (CILOs)

(CILOs state what the student is expected to be able to do at the end of the course according to a given standard of performance.)

No.	CILOs	Weighting (if applicable)	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			A1	*A2*	*A3*
1.	Explain the theory and modelling of stochastic processes. Discovering the rationale behind the quantitative analysis.	25%	√	√	√
2.	Design and discover discrete time models and Brownian motion equations to address financial problems and construct innovative solutions.	20%	√	√	√
3.	Justify and apply Ito's calculus. Demonstrate the ability to derive Ito's formula to solve stochastic differential equations with innovative insights.	20%	√	√	
4.	Derscribe the Black-Scholes Formula by using partial differential equations (PDEs). Discovering the logic behind the Black-Scholes Formula, a widely used formula.	25%	√		
5.	Design delta and gamma hedging strategies. Demonstrate the ability to generate innovative solutions towards risk management problems.	10%	√		
		100%			

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: *Accomplishments*
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

3. Learning and Teaching Activities (LTAs)

(LTAs designed to facilitate students' achievement of the CILOs.)

LTA	Brief Description	CILO No.					Hours/week (if applicable)
		1	2	3	4	5	
Lectures	Students will engage in formal lecture which will introduce basic concepts and structure. Students are expected to discover the theory on stochastic calculus and understand the modelling on asset valuation, followed by the hedging functions of various financial products.	√	√	√	√	√	2 hours per week
Tutorial and in-class discussion	Students will be encouraged to think critically and logically by responding to questions and solving the problems by themselves to apply knowledge and theory. Even though the suggested solutions may be given, this process motivates students to be innovative. Through active in-class discussion, the communication skills of students will also be enhanced.	√	√	√	√	√	1 hour per week

4. Assessment Tasks/Activities (ATs)

(ATs are designed to assess how well the students achieve the CILOs.)

Assessment Tasks/Activities	CILO No.					Weighting	Remarks
	1	2	3	4	5		
Continuous Assessment: 50%							
Assignments Students will perform analyses on various modelling problems. They will be required to apply mathematical theories to generate innovative solutions for certain problems facing the finance industry.	√	√	√	√	√	50%	
Examination: 50% (duration: 3 hours) The final examination which covers topics discussed in lectures and tutorials, will also reveal the students' accomplishments of discovery and innovation.							
						100%	

5. Assessment Rubrics

(Grading of student achievements is based on student performance in assessment tasks/activities with the following rubrics.)

Applicable to students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
Final Examination	Ability to apply the theory of stochastic calculus and explain its concepts	High	Significant	Moderate	Basic	Not even reaching marginal levels
Assignments	Capacity for discovering/ deriving results complementing the theory of stochastic calculus covered by the lectures and for applying the theory	High	Significant	Moderate	Basic	Not even reaching marginal levels

Applicable to students admitted from Semester A 2022/23 to Summer Term 2024

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B)	Marginal (B-, C+, C)	Failure (F)
Final Examination	Ability to apply the theory of stochastic calculus and explain its concepts	High	Significant	Basic	Not even reaching marginal levels
Assignments	Capacity for discovering/ deriving results complementing the theory of stochastic calculus covered by the lectures and for applying the theory	High	Significant	Basic	Not even reaching marginal levels

Part III Other Information (more details can be provided separately in the teaching plan)

1. Keyword Syllabus

(An indication of the key topics of the course.)

1. Partial Differential Equations
2. Two-instants model
3. N-instants model
4. Self-financing portfolio
5. Risk neutral measure
6. Arbitrage opportunity
7. Market completeness
8. Filtration
9. Brownian motion
10. Stochastic processes
11. Itô formula
12. Black-Scholes Formula
13. Delta hedging
14. Gamma hedging

2. Reading List

2.1 Compulsory Readings

(Compulsory readings can include books, book chapters, or journal/magazine articles. There are also collections of e-books, e-journals available from the CityU Library.)

1.	*Stochastic Calculus for Finance II: Continuous-Time Models* by Steven E. Shreve, Springer Finance.

2.2 Additional Readings

(Additional references for students to learn to expand their knowledge about the subject.)

1.	*Stochastic Calculus and Financial Applications* by J. Michael Steele.
2.	*An Introduction to Measure Theory* by T. Tao, American Mathematical Society.